Historical Review Uranium-Vanadium Production in the Northern and Western Carrizo Mountains, Apache County, Arizona

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Abstract

The carnotite deposits of the northern and western Carrizo Mountains have been mined for their radium, vanadium, and uranium content since 1920. The deposits, in the Salt Wash Member of the Morrison Formation, were discovered about 1918 by John F. Wade. In November 1920, Wade's Radium Ores Company shipped 40,000 pounds of ore, probably to a buying station in Colorado

During the early 1940s, in response to a vanadium purchasing program by the Federal Government, a total of 11,205 tons of ore averaging 2.24 percent V_2O_5 were produced from five leases in the northern and western Carrizos. Uranium for the secret wartime Manhattan Project was recovered from the ores at Monticello, Utah and Durango, Colorado

Mining resumed in the Carrizo Mountains in 1948 as the result of the Atomic Energy Commission's (AEC) uranium procurement program. From 1948 through 1966, some 60 properties in the northern and western Carrizo Mountains produced a total of 73,118 tons of ore averaging 0.21 percent U_3O_8 and 1.64 percent V_2O_5. Properties originally acquired for vanadium mining in the 1940s accounted for 77 percent of the uranium produced under the AEC program.

Introduction

In 1980, a report with the same title was open filed by the Grand Junction Office of the U. S. Department of Energy, (DOE) as Technical Memorandum No. 209. Since this report was released,

considerable new information bearing on the early mining history the Carrizo Mountains has become available.

The principal source of new data is a detailed report prepared by the General Services Administration (GSA), Indian Trust Accounting Division for the Navajo Tribe. This document (GSA, 1981) was admitted as evidence in U.S. Claims Court, Navajo Tribe vs United States, Docket Nos. 69 and 299 (copper, vanadium uranium, sand, rock and gravel claims) held in Albuquerque, New Mexico, February 24-March 4, 1983. A copy of the vanadium and uranium section was made available to the Grand Junction Area Office of the Department of Energy.

A review of the Vanadium Corporation of America's (VCA) 1947-1953 mill receipts to the Atomic Energy Commission (AEC), located in the DOE archives at Grand Junction, added to our knowledge of the early mining, especially the names of the individuals that operated the VCA mines under contract

The property known only as Carrizo Mountain in TM-209 was identified as initial shipments from Cato Sells' mining permit on Cove Mesa. Also, two properties, Horsefly and Chimney No. 1, were confirmed to be located in the Carrizo Mountains, Apache County, Arizona, although their exact location is unknown

As this report deals only with historical production data, the reader is referred to reports by Chenoweth (1955), Corey (1956), Hatfield and Maise (1953), Hershey (1958), Jones (1954) Stokes (1951, 1953, 1954) for descriptions of the geology and ore deposits. Government drilling projects in the area are summarized by Blagbrough and others (1959), Bollin and others

(1956), Chenoweth (1956), Garcia (1952), and Hall and Moore (1950). A report by Albrethsen and McGinley (1982) gives the details of the AEC's uranium procurement program and a history of the uranium processing plants. Figure 1 shows the locations of the mines and production is summarized in Table 1 and Figure 2.

A New Mexico Bureau of Mines and Mineral Resources report (Chenoweth and Learned, 1984) covers the production history of the eastern Carrizo Mountains.

Early Prospecting

Outcrops containing uranium/vanadium minerals in the Carrizo Mountains were discovered by John F. Wade about 1918 (pers. comm. 1955). Wade of Farmington, New Mexico, operated the Sweetwater Trading Post in the western Carrizo Mountains. Through business contacts and field trips, he had determined that the same rocks that contained the carnotite deposits of southwestern Colorado were present in the Carrizo Mountains. These rocks would later be named the Salt Wash Member of the Morrison Formation. The newly discovered deposits could not be mined since the Navajo Reservation was closed to prospecting and mining. A Congressional Act of June 30, 1919, opened the Navajo Reservation to prospecting and locating mining claims in the same manner as prescribed by the United States Mining Law. This Act allowed prospectors to enter the Reservation and stake a mining claim if their prospecting located promising mineralization. The locator of the claim then obtained a lease on this land under terms that included escalating advance royalties and rentals, and annual work commitments.

By 1920, the Radium Ores Company, John F. Wade, president,

TABLE 1

DETAILS OF URANIUM/VANADIUM PRODUCTION

NORTHERN AND WESTERN CARRIZO MOUNTAINS, APACHE COUNTY, ARIZONA

(Revised 9/1/83)

Index No.	Mine Name	Tons Ore	Pounds U_3O_8	% U_3O_8	Pounds V_2O_5	% V_2O_5	Periods of Production/Operator(s)
1.	Barton 3	31	75	.12	324	.52	1954- Lewis Barton
2.	Tom Morgan	10	49	.24	156	.76	1955- E.F. Peters Formation Logging Service
3.	John Lee Benally	37	126	.17	318	.43	1963- Vanadium Corp. of America (VCA)
4.	Phillip Dee 1	154	134	.04	288	.09	1954-55- Granger Uranium Co.
5.	Johnny McCoy 1	34	41	.06	61	.09	1955- H & H Minerals
6.	Brodie 1	5	150	1.37	350	3.20	1951- Mike Brodie
7.	John Kee 4	926	2,773	.15	16,814	.91	1955- Uranium Reserve Corp.
8.	Capitan Benally 4A	114	478	.21	3,135	1.38	1957- Climax Uranium Co. 1957- Jimmie King
9.	Block K	2,016	7,044	.17	52,342	1.30	1962-63- Kerr-McGee 1963-64- VCA
10.	Silentman 1	12	19	.08	2	.008	1958- Harold Broshears
11.	McKenzie 3	504	1,846	.18	16,520	1.64	1955-56- Lone Star Mining & Development Co.
12.	Plot 1 (Hogan Mine)	- - - - - - See Footnotes 1 and 2 - - - - - -					1942-44, 1949 - VCA
13.	Plot 2	- - - - - - - - See Footnote 2 - - - - - - - -					1949- VCA
		163	710	.22	5,934	1.82	1960- C.H.Corey, Jr. 1960-61- Thomas Clani
14.	Plot 4 (Gila Mine)	- - - - - - - - See Footnote 2 - - - - - -					1949- VCA
		22	82	.17	739	1.68	1954- VCA
15.	Pope 1	423	2,850	.34	15,196	1.80	1959- Capitol Seaboard Corp.
16.	Hoskie Henry	978	3,840	.20	25,276	1.29	1964-66- VCA

Index No.	Mine Name	Tons Ore	Pounds U_3O_8	% U_3O_8	Pounds V_2O_5	% V_2O_5	Periods of Production/Operator(s)
17.	Plot 6 (Rattlesnake Mines)	- - - - - - See Footnotes 1 and 2 - - - - - -					1943-44, 1948-52- VCA
		7,365	30,319	.21	217,062	1.47	1951-53- Earl Saltwater 1951-52- Leo Redhouse 1953-56, 1962-68- VCA 1955-56 - Thomas Clani 1958-59- Capitol Seaboard Corp.
18.	Black Rock Point Mines	2,025	8,217	.20	53,764	1.33	1951-58, 1962- Thomas Clani 1965-66- VCA
19.	Plot 8	- - - - - - See Footnotes 1 and 2 - - - - - -					1943-44, 1949- VCA
		28	98	.18	1,000	1.80	1950- VCA
20.	Sandy K	7	19	.13	81	.57	1955- George W. Smith, Sr.
21.	Jimmie Bileen 1	67	268	.20	1,752	1.31	1955-57- M & M Mining Co.
22.	Plot 9	- - - - - - See Footnotes 1 and 2 - - - - - -					1942-44, 1949- VCA
23.	Plot 10 (Horse Mine)	- - - - - - See Footnotes 1 and 2 - - - - - -					1942-44, 1949- VCA
	H & R Nez [3]	8	16	.10	195	1.19	1957- U & L Mining Co.
24	Plot 11 (Two Level Mine)	- - - - - - See Footnotes 1 and 2 - - - - - -					1942-44, 1949- VCA
25.	Plot 7 (Rattlesnake No. 5 Mine)	- - - - - - See Footnotes 1 and 2 - - - - - -					1942-44, 1949- VCA
26.	Tsosie 1	25	55	.11	647	1.30	1955- G. B. Cree Drilling Co.
27.	Grover Cleveland 1	28	126	.22	1,040	1.84	1957- U & L Mining Co.
28.	Plot 12 (Rattlesnake No. 8 Mine)	- - - - - - See Footnotes 1 and 2 - - - - - -					1942-44, 1949- VCA
29.	North Martin (AEC Plot 2)	- - - - - - - - See Footnote 4 - - - - - - - -					1943-44- Curran Brothers & Wade
30.	Martin (AEC Plot 1)	- - - - - - - - See Footnote 5 - - - - - - - -					1942-43- Wade, Curran & Co.
		1,481	7,705	.26	57,167	1.93	1951- Leo Redhouse 1953-54- Jimmie King 1954-55- George R. Simpson
	George Simpson 1 (access thru Martin Mine)	1,697	8,372	.25	63,460	1.87	1954-56- George R. Simpson
31.	George Simpson 1 Incline	2,000	7,901	.20	56,160	1.40	1957- Capitol Uranium Co. 1957-58- Capitol Seaboard Corp.

Index No.	Mine Name	Tons Ore	Pounds U_3O_8	% U_3O_8	Pounds V_2O_5	% V_2O_5	Periods of Production/Operator(s)
32.	Last Chance	32	107	.17	857	1.34	1961-62- Harold Broshears 1965- Curtis W. Jones
33.	Carson	93	410	.22	2,846	1.53	1958- Capitol Seaboard Corp.
34.	Plot 13	- - - - - - - - See Footnote 1 - - - - - - - -					1942-44- VCA
35.	Saytah	- - - - - - - - See Footnote 5 - - - - - - - -					1942-43- Wade, Curran & Co.
		1,926	8,843	.23	72,463	1.88	1956- George Simpson
36.	Melvin Benally 1	147	522	.18	4,669	1.59	1955- Byden Mines, Inc.
37.	Saytah Canyon (AEC Plot 4)	- - - - - - - - See Footnote 4 - - - - - - - -					1943-44- Curran Brothers & Wade
		112	402	.18	3,833	1.71	1950- Thomas Benally 1951- Thomas Clani 1951- Leo Redhouse
38.	School Boy	109	199	.09	5,077	2.33	1955-56- American Uranium Co.
39.	CBW-MC Mine (AEC Plot 5)	- - - - - - - - See Footnote 4 - - - -					1943-44- Curran Brothers & Wade
40.	Eurida Mines (AEC Plot 6)	- - - - - - - - See Footnote 5 - - - -					1942-43- Wade, Curran & Co.
41.	Eurida Mesa (Plots 14, 15, 16)	467	1,559	.17	26,727	2.86	1950-51- Thomas Clani 1951- John Joe 1951- Mike Brodie 1956- VCA
42.	Sunnyside	- - - - - - - - See Footnote 6 - - - - - - -					1943- Wade, Curran & Co.
		28	91	.16	1,738	3.10	1955- Frontier Mining
43.	Mildred 1	25	25	.05	1,350	2.68	1956- Yazzie Mining & Development.
44.	Chester Mud 1	159	470	.15	3,461	1.09	1955- Earl R. Hodge 1955- Chester Mud 1956-57- Mud Mesa Mining Co.
45.	Sheepskin Mesa	82	351	.21	3,153	2.14	1950- Roy Hosteen & Lee Yazzie 1953- J. C. Foutz
46.	Tree Mesa (Clani)	47	78	.08	682	.72	1952- Thomas Clani
47.	Kinusta Mesa (AEC Plot E)	788	1,330	.08	28,386	1.80	1949-50- VCA 1950- - Thomas Clani 1951- - Mike Brodie 1951-52- Thomas Hanley 1958- - VCA

Index No.	Mine Name	Tons Ore	Pounds U_3O_8	% U_3O_8	Pounds V_2O_5	% V_2O_5	Periods of Production/Operator(s)
48.	Tohe Thlany Begay	253	758	.15	13,348	2.64	1950-51- Bennie Tohe 1953- Carl Chelf 1955- Sam Foster
49.	Cove Mesa Mines (Sells)	2,691	8,082	.15	90,742	1.69	1950,1953, 1956-58- Cato Sells 1962-64- VCA
50.	Cove Mesa Mines (AEC Plot 7)	35,963	161,139	.22	1,160,403	1.61	1948-51, 1954-65- VCA 1950, 1952- Cato Sells 1950, 1952- Harvey Young 1951, 1953-57- Leroy Pettigrew 1952- John Woodrow 1956- James Benally 1956- George R. Simpson 1959-60- William Wittmeyer 1960-61- C. H. Corey, Jr. 1961- Woodrow E. Gripe 1964- William George
51.	East Mesa Mines	994	4,646	.23	12,098	.61	1951-53- Leroy Pettigrew 1953, 1955- Pettigrew & Davis
52.	West Mesa Mine	72	169	.12	1,175	.82	1955- Pettigrew & Worley
53.	Rattlesnake No.	- - - - - - - - See Footnote 7 - - - - - - - -					1944- VCA 1948-49- VCA 1950- Leo Redhouse 1955-56- Sylvania Mining Co.
		1,054	3,471	.16	35,775	1.70	
54.	Bettie 1	53	192	.18	955	.90	1955-56- Hamilton & Wilhite
55.	Zona 1	2,116	8,224	.19	123,092	2.91	1953-55- James B. Ashcroft
56.	Ruben 1	64	283	.22	2,700	2.11	1955- DeGeer & Isbell 1955- Edwards & Mallery

Index No.	Mine Name	Tons Ore	Pounds U_3O_8	% U_3O_8	Pounds V_2O_5	% V_2O_5	Periods of Production/Operator(s)
57.	Jim Lee 1	120	287	.12	4,218	1.76	1955- Mexona Corp.
57.	Richard King 1	57	209	.18	3,170	2.78	1955- G.B. Cree Drilling Co.
58.	Todakonzie 1	6	23	.21	201	1.66	1955- Haskell Uranium Co.
	West Reservation Lease 8/	5,417	21,691	.20	195,794	1.81	1948-50- VCA 1950- Leo Redhouse 1950-51- Earl Saltwater 1950-52- Thomas Clani 1951- Thomas Benally
	Horsefly 9/	12	7	.03	501	2.09	1950- Roy Hosteen & Lee Yazzie
	Chimney No. 1 9/	71	140	.10	2,525	1.78	1951- Henry Pie & Richard Harrison

1/ During the period May 1942 through February 1944, shipments from the West Reservation Lease totaled 7,504 tons of ore averaging 1.83% V_2O_5. Mining was on Plots 1, 6-13.

2/ Early, 1948-52, production shipped as West Reservation Lease, plots not differentiated. See Footnote 8.

3/ Material mined from dumps on Plot 10.

4/ During the period December 1943 through February 1944, a total of 388 tons of ore averaging 1.94% V_2O_5 was shipped from the North Martin, Saytah Canyon and Main Claim Mines.

5/ During the period August 1942 through November 1943, a total of 2,198 tons of ore averaging 2.91% V_2O_5 was shipped from the Martin, Saytah and Eurida Mines.

6/ During the period July 1942 through October 1943 a total of 966 tons of ore averaging 4.37% V_2O_5 was shipped from the Sunnyside and Syracuse Mines (Syracuse is in the eastern Carrizos).

7/ During the period April through July 1944 a total of 146 tons of ore averaging 0.12% V_2O_5 was shipped from the Rattlesnake No. 1 mine.

8/ Production from Plot 6, includes minor production Plots 1, 2, 4, and 7-12.

9/ Location unknown.

SOURCE: AEC production records, GSA report, AEC field notes, VCA mill receipts, and Bureau of Indian Affairs records.

had located 28 claims in the northern and western Carrizo Mountains Wade, also operating as the Carriso Uranium Company, had 40 claims astride the New Mexico-Arizona state line in the vicinity of Milepost 16, in the eastern Carrizo's.

According to the GSA (1981) report the Radium Ores Company's holdings consisted of seven leases totalling 570.016 acres. The leases were effective December 23, 1922. Details of the leases are given in Table 2.

In November 1920 (GSA, 1981, p. 1 of appendix) Radium Ores Company produced 40,000 pounds or ore valued at $1,600.00 A transportation charge of $1,200 left the value at only $400. It is possible that this material was shipped to the Standard Chemical Co.'s ore-buying station near Naturita, Colorado which was buying carnotite ores for their radium content in the 1910s and 1920s. The November 1920 shipment represented the first production of carnotite ore from the Carrizo Mountains

When the area of the leases was first examined by a U. S. Geological Survey engineer in October 1929 (Dyer, 1929), he noted numerous open pits had been dug in mineralized outcrops, especially on the Say Tah and Martin claims.

On March 25, 1936, the Secretary of the Interior closed the Navajo Indian Reservation to claim location and prospecting for minerals until further authorization. In July, 1936, an application to prospect was made to the Executive Committee of the Navajo Tribal Council in the form of asking the Council to pass a resolution requesting the Secretary of Interior to open the Navajo Reservation for mining to the applicant. The resolution was

TABLE 2
DETAILS OF RADIUM ORES CO'S LEASES

Acres In Lease	Claims	Location
20.661	Sunnyside	Sunnyside Mesa
103.305	Eurida Nos. 1, 2, 3, 5	Eurida Mesa
20.661	Eurida No. 4	Eurida Mesa
61.983	Preston, Preston No. 1, Stormy Day	Saytah Wash
82.644	Preston Nos. 2, 34, 5	Saytah Wash
41.322	Say Tah, Martin	Saytah Wash
239.440	Martin Nos. 2-13	Saytah Wash
570.016 total acres		

Source: GSA (1981, p. 1 of appendix)
Dyer (1929)

rejected by the Executive Committee, which evidently did not want prospecting or mining on the Reservation at that time.

Vanadium Mining

By the late 1930s, the mines in the carnotite region of southwestern Colorado and southeastern Utah were being reopened for their vanadium content. At the same time, the Secretary of the Interior was being asked to open the Navajo Indian Reservation for prospecting and mining.

The Navajo Reservation was opened by a Congressional Act of May 11, 1938, but with new procedures. This Act gave the Tribal Council the authority to enter into leases for the Reservation lands with approval of the Secretary of Interior. Prospectors no longer could enter the Reservation and stake a mining claim under regulations similar to those of the United States Mining Law. The new mining regulations contained escalating annual rentals, a base royalty of 10% (mine mouth value), bond requirements, acreage limitations, a term of 10 years which could be extended by production

Due to the uncertainty of foreign supplies and the need for vanadium for war armaments, the federal government formed the Metals Reserve Company in 1942. The company began an ore-purchasing program and increased the base price paid for vanadium ore. At Monticello, Utah, the Defense Plant Corporation, a Government Agency, funded the construction of a vanadium plant to be operated by the Vanadium Corporation of America (VCA). Actual construction started in February and on August 24, 1942, the first vanadium was produced. In April 1942, while construction was under way, the

Metals Reserve Company (MRC) established an ore buying station at Monticello, and appointed the United States Vanadium Corporation (USV) as its buying agent. All ore producers, independents and VCA, then sold ore to the MRC. MRC in turn had the ore milled by VCA or other mills.

At Durango, Colorado, the Reconstruction Finance Corporation, a Government Agency, contracted with USV to convert and operate an old lead smelter for vanadium production. The vanadium was supplied to Metals Reserve Company. United States Vanadium operated the plant for the Government until early 1944, when the Government vanadium purchasing program was terminated because of adequate vanadium stocks. U.S. Vanadium Corporation then purchased the facilities from the Reconstruction Finance Corporation and operated them for the production of vanadium for commercial sales until August 31, 1945, when the plant was closed

The Metals Reserve's program was the stimulus to revive mining in the Carrizos

On December 4, 1939, effective January 19, 1940, John F. Wade, Thomas F. V. Curran, and H. R. Redington (d.a.b. Wade, Curran and Co.) leased 65.02 acres in the Carrizo Mountains. Their lease, I-149-IND-3798 covered the Martin Claim, Say-Tah Claim, and the Eurida No. 2 Claim as described in U.S. Mineral Survey Nos. 3701 and 3703. The lease was for a period of five years

These are three of the properties formerly held by Wade's Radium Ores Company. Shipments from Lease I-149-IND-3798 were recorded from August 1942 through November 1943. Details of the production are given in Table 3.

TABLE 3
VANADIUM PRODUCTION 1942-1943
LEASE I-149-IND-3798
WADE, CURRAN AND CO.

Year	Tons of Ore	Pounds V_2O_5	Percent V_2O_5
1942	302	44,948	7.44
1943	1,896	82,961	2.19
Totals	2,198	127,909	2.91

Source: GSA (1981, p. 5-20 of appendix)

Although the production is not separated by claim, Wade (pers. comm., 1955) stated that the ore-bearing outcrops along Saytah Wash were the first to be mined. Ore mined by Wade, Curran and Company was shipped by truck to Farmington, New Mexico and then by rail to the mill at Durango, Colorado. Lease I-149-IND-3798 was due to expire on January 19, 1945 but was apparently cancelled earlier.

On April 5, 1940, effective May 9, 1940, John F. Wade, Thomas F. V. Curran, and H. R. Redington (d.b.a. Wade, Curran Co.) leased an additional 42.32 acres in the Carrizo Mountains This lease, I-149-IND-4225, covered the Sunnyside Lode Claim of 20.66 acres in the western Carrizo's and the Syracuse Lode Claim of 20.66 acres in the eastern Carrizo's. The claims were described by U.S. Mineral Survey Nos. 3700 and 3857. The lease was for a period of five years.

The Sunnyside claim had also been held by Wade's Radium Ores Company. Shipments from Lease I-149-IND-4225 was recorded from May 1942 through October 1943. Details of the production are

given in Table 4

TABLE 4
VANADIUM PRODUCTION 1942-1943
LEASE I-149-IND-4225
WADE, CURRAN AND CO.

Year	Tons of Ore	Pounds V_2O_5	Percent V_2O_5
1942	246	44,075	8.96
1943	720	40,343	2.80
Totals	966	84,418	4.37

Source: GSA (1981, p. 21-30 of appendix)

Shipments from the two claims are not separated, but John Wade (pers. comm. 1955) stated that the Syracuse was the first property to be mined. Harshbarger (1946, p. 25) reports that from May through October 1943, shipments from the Sunnyside Mine totalled 475 tons of ore containing 24,395 pounds V_2O_5 and averaging 2.57 percent V_2O_5. Ore from this lease was also shipped to Durango, Colorado. Lease I-149-IND-4225 was due to expire on May 9, 1945 but was apparently cancelled earlier.

On April 9, 1941, the Navajo Tribal Council requested the Secretary of the Interior to lease lands for mining purposes to the highest bidder. In order to take care of this situation, the mining leases were written for large areas and subsequently reduced in acreage at the end of a specified time period. The net effect of this type of lease was that a prospecting permit was issued to the highest bidder, who then had the right to lease land within the permit area up to a maximum acreage.

The first sale to be held under the new bidding regulations was in the northwestern Carrizo Mountains. On November 28, 1941 the Office of Indian Affairs advertised an exploration mining lease sale, for carnotite and related minerals, for 144 square miles in Apache County, Arizona. The tract was described as: "unsurveyed land which was designated on an unapproved survey as Township 12 and 13 North, Range 7 West, and Township 12 and 13 North, Range 6 West, Navajo Meridian."

Bids were opened on December 19, 1941, at which time two bids were received; VCA, Naturita, Colorado, $2,000.00; and King Lease, Inc., Ouray, Colorado, $100.00 (GSA, 1981, exhibit 26) Lease I-149-IND-5456 was executed with VCA on December 26, 1941, effective February 23, 1942 for a period of ten years. Ore shipments to the Monticello mill commenced in May 1942 continued through February 1944.

Lease I-149-IND-5465 was commonly referred to as the "West Reservation Lease" by VCA. Details of the vanadium production are given in Table 5

TABLE 5
VANADIUM PRODUCTION 1942-1944
VCA'S WEST RESERVATION LEASE

Year	Tons of Ore	Pounds V_2O_5	Percent V_2O_5
1942	1,468	55,111	
1943	5,636	204,919	
1944	400	14 381	1.80
Totals	7,504	274,411	1.83

Source: GSA (1981, p. 31-36 of appendix)

The May 1942 shipments were the first vanadium ore produced in the Carrizo Mountains under the Metals Reserve program. The ore came from the Rattlesnake Mines in the Saytah Wash area (Duncan and Stokes, 1942, p. 22).

On September 2, 1943, the lease was reduced to a permanent operating lease and 16 plots (claims) totalling 229.14 acres were selected to be retained. Details of these plots are given in Table 6.

On July 21, 1943, in response to requests from mining companies, the Office of Indian Affairs advertised an exploration mining lease sale for carnotite and related minerals in the northern and western Carrizo Mountains. The area offered consisted of 168 square miles in a tract 7 miles wide east-west, and 24 miles long, north-south, with the southeast corner located near Cove School (Fig. 1). Excluded were all lands subject to prior approved mineral leases.

Bids were opened on August 3, 1943 at which time the only bid received was $5,085.00 from Thomas F. V. Curran, Charles F. Curran

TABLE 6
LOCATION AND SIZE OF PLOTS
VCA'S WEST RESERVATION LEASE

Number	Mine Name*	Acres	Location
1	Hogan	10.33	Canyon W. of Saytah Wash
2		10.33	Canyon W. of Saytah Wash
3		10.33	Canyon W. of Saytah Wash
4	Gila	10.33	Canyon W. of Saytah Wash
5		10.33	W. side Saytah Wash
6	Rattlesnake Mines	52.36	E. of Saytah Wash
7	Rattlesnake No. 5	2.14	E. side Saytah Wash
8		10.41	Canyon E. of Saytah Wash
9		9.77	Rattlesnake Canyon
10	Horse	10.19	Rattlesnake Canyon
11	Two Level	7.41	Rattlesnake Canyon
12	Rattlesnake No. 8	18.13	E. side Saytah Wash
13		7.92	E. side Saytah Wash
14		20.66	N. Eurida Mesa
15		31.74	S. Eurida Mesa
16		6.76	S.W. Eurida Mesa
	Total	229.14 acres	

*Mining has occurred on all plots, but only seven have named mines.

and John F. Wade, d.b.a. Curran Brothers and Wade (GSA, 1981, exhibit 38). Lease I-149-IND-6197 was executed on August 6, 1943, effective October 27, 1943 for a period of ten years. On the date the lease became effective, a two thirds interest was assigned to U.S. Vanadium Corp. (USV).

Shipments commenced in December 1943 and continued through February 1944. Details are given in Table 7.

TABLE 7
VANADIUM PRODUCTION 1943-1944
CURRAN BROTHERS AND WADE-U.S. VANADIUM LEASE

Year	Tons of Ore	Pounds V_2O_5	Percent V_2O_5
1943	170	7,390	2.17
1944	218	7,670	1.76
Totals	388	15,060	1.94

Source: GSA (1981, p. 50-54 of appendix)

The ore was mined from the Saytah Canyon Mine and the CB & W Main Claim Mine in Saytah Canyon and from the North Martin Mine in Saytah Wash. A small amount may have been mined from the west side of Cove Mesa (Harsbarger, 1946, fig. 3). The ore was shipped by truck and rail to the mill at Durango, Colorado

On March 22, 1944 the lease was reduced to a permanent operating lease with 12 plots, totalling 960 acres, selected to be retained. Details of these plots are given in Table 8. Included in this selection were a few plots previously held under Lease I-149-IND-3798

TABLE 8
LOCATION AND SIZE OF PLOTS
CURRAN BROS. AND WADE-U.S. VANADIUM LEASE

Number	Mine Name	Acres	Location
1	Martin	20.2	West side Saytah Wash
2	North Martin	14.4	West side Saytah Wash
3		2.2	East side Saytah Wash
4	Saytah Canyon	10.4	North side Saytah Canyon
5	Main Claim	5.7	South side Saytah Canyon
6	Eurida	20.6	Eurida Mesa
7		246.2	South 2/3 Cove Mesa
A		16.0	East end Saytah Canyon
B		17.3	NW point Segi Ho Cho Mesa
C		34.9	SW point Segi Ho Cho Mesa
D		37.8	SW point Segi Ho Cho Mesa
E		529.0	East end Kinusta Mesa
	Total	959.7	

A plot on Sunnyside Mesa was not selected due to the 960-acre limitation on total land that could be held by one organization on the Navajo Reservation. Selection and surveying of the plots were done primarily by personnel of the Union Mines Development Corp., who would later acquire Lease I-149-IND-6197

In the fall of 1943, Navajo prospectors located vanadium-bearing outcrops of the Salt Wash sandstone about three miles southwest of Teec Nos Pos Trading Post.

VCA asked the Office of Indian Affairs that a 13.50 acre tract was advertised on January 11, 1944, and when the bids were

opened on February 1, 1944, VCA was the only bidder with a bonus bid of $600.00

Lease I-149-IND-6342 was executed on February 8, 1944 effective April 1, 1944. VCA named the lease Rattlesnake No. 1.

During the months April through July 1944, the Rattlesnake 1 Lease produced 146 tons of ore containing 361 pounds V_2O_5 and averaging 0.12 percent V_2O_5 (GSA, 1981, p. 62-63 of appendix). Since the Metals Reserve program had terminated in March 1944, this was trucked to VCA's vanadium mill at Naturita, Colorado. Shipments from the Rattlesnake No. 1 Lease would represent the last production from the northern and western Carrizo Mountains until 1948

In summary, during the years 1942 through 1944, vanadium ore was produced from five leases in the northern and western Carrizo Mountains. A total of 11,205 tons of ore containing 502,159 pounds V_2O_5 and averaging 2.24 percent V_2O_5 was produced. Table 9 gives the summary of this production.

TABLE 9
SUMMARY OF VANADIUM PRODUCTION, 1942-1944

Lease No.	Tons of Ore	Pounds V_2O_5	Percent V_2O_5
I-149-IND-3798	2,198	127,909	2.91
I-149-IND-4225	966	84,418	4.37
I-149-IND-5456	7,504	274,411	1.83
I-149-IND-6197	388	15,060	1.94
I-149-IND-6342	146	361	0.12
Totals	11,202	502,159	2.24

U. S. Geological Survey Studies

As part of the U. S. Geological Survey's (USGS) investigations of critical war materials, the uranium-vanadium deposits of the Carrizo Mountains were examined during October and November, 1942

The USGS geologists examined and mapped the existing mines, and acquired production history and statistics from the mine operators. Estimates of the vanadium ore reserves also were made (Table 10).

TABLE 10
VANADIUM ORE RESERVES
NORTHERN AND WESTERN CARRIZO MOUNTAINS, 1942

Area	Inferred Ore Tons	Inferred Ore % V_2O_5	Indicated Ore Tons	Indicated Ore % V_2O_5
Rattlesnake Mine	6,700	1.5-2	7,000	1
Hogan Mine	1,300	1.5-2	16,000	1
Eurida Mine	1,200	2-2.5	12,000	2-2.5
Other prospects	2,000	1-2.5	3,500	1-2.5
Totals	10,200	1.5-2	38,500	1.5-2

The detailed results of the October-November 1942 investigations are in a report by Duncan and Stokes (1942) which was submitted to the Manhattan Engineer District. The general geology and the description of the ore deposits was later published by Stokes (1951).

Manhattan Engineer District Activities

During World War II the Army Corps of Engineers formed the Manhattan Engineer District (MED) for the development of atomic weapons and acquisition of raw materials for the production of weapons. The Murray Hill Area of MED was established on June 15, 1943 for the major purpose of the exploration and development of raw materials on which the entire Manhattan Project was dependent Determination and evaluation of the uranium resources of the world was first undertaken, and the program was later expanded to include thorium ores

A contract, No. W-7405 Eng-78, effective May 11, 1943, was made with Union Mines Development Corporation (UMDC), a subsidiary

of Union Carbide and Carbon Corporation, for carrying out work. The contract provided that all costs should be reimbursed by the Government, with no fixed fee or profit to UMDC

On the Colorado Plateau, UMDC's geologic investigations were limited to the Salt Wash Member of the Morrison Formation, and the Entrada Sandstone in the area of the roscoelite deposits

Geologic studies and resource estimates for the northern and western Carrizo Mountains are contained in reports by Webber (1943), Eakland (1946), and Harshbarger (1946). All of the known outcrops of uranium/vanadium minerals, prospects, and mines were mapped and described by UMDC geologists. After mapping and sampling the mines, UMDC geologists estimated the uranium content of some 6,924 tons of mined vanadium ore at 0.15 percent U_3O_8. The geologists also proposed an exploration program for developing additional ore reserves

As part of their investigations, UMDC geologists recommended areas that should be acquired by the Federal government for the development of uranium resources. In the northern and western Carrizo Mountains, UMDC took action to acquire the lease of Curran Brothers and Wade-U. S. Vanadium, which consisted of 12 plots, UMDC had helped to select. On April 17, 1944, the one third interest in Lease I-149-IND-6197 held by Curran Brothers and Wade, was reassigned to Union Mines. The two thirds interest held by USV was reassigned to UMDC on April 24, 1944. Both reassignments were approved by the Office of Indian Affairs on October 31, 1944.

Late in 1942 and early in 1943 the Manhattan Engineer District (MED) began a program to obtain uranium from domestic

sources. In January 1943, VCA agreed to produce a uranium-vanadium (U-V) sludge at Monticello that was sold by MRC to MED on a unit price basis. The sludge contained 45 to 50% U_3O_8 and about 25% V_2O_5 and was shipped to the Vitro Manufacturing Co. at Canonsburg, Pennsylvania, for additional processing. Tailings from the Monticello mill were considered by the MED to be too low in uranium for additional processing. In February 1944, MRC closed the Monticello mill and ceased production of both fused oxide (V_2O_5) and the U-V sludge.

In 1945 VCA leased the Monticello mill from the Defense Plant Corporation and purchased from MRC the remaining ore stockpiles VCA processed the stockpiled ore plus ore from other sources, and sold a U-V sludge to the MED until the mill closed again in 1946.

During the 1943-1944 period USV constructed and operated a uranium-vanadium sludge plant at the Durango site, under a cost-plus-fixed-fee agreement with the MED. Feed for the plant consisted of vanadium tailings from past and current operations. The sludge was shipped to a refinery at Grand Junction, Colorado, also operated for the MED by USV. There, the vanadium was removed to make the sludge suitable for further refining to black oxide. Details of MED's uranium procurement activities are given in a report by the Manhattan District Engineers (1982).

Uranium Mining

The Atomic Energy Commission was established by the Atomic Energy Act of August 1, 1946, in recognition of a need to provide for a civilian Government agency which could assure the continued

development of atomic energy for military purposes and also promote the research and development necessary to the utilization of atomic energy for peaceful applications.

During World War II the Manhattan Engineer District, under the Army Corps of Engineers, had been charged with the development of atomic weapons. Its activities included research and development, engineering and design, the operation of production facilities for weapons materials and components, and the acquisition of uranium for the production of nuclear weapons.

All of these MED functions, and the numerous Government-owned facilities in which many of them were being performed, were transferred to the AEC by Executive Order 9816, effective at midnight, December 31, 1946. An Office of New York Directed Operations was established by the AEC on June 9, 1947, and that office supervised the procuring and processing of uranium until the AEC's Division of Raw Materials was formed in October 1947 to direct those activities from the AEC's Headquarters office in Washington, D.C.

On the Colorado Plateau, the AEC began a procurement program for uranium concentrate. The first domestic contract was signed with VCA on August 28, 1947, effective May 20, 1947 to purchase uranium concentrates from the company's Naturita, Colorado mill. The AEC also contracted with VCA, effective October 8, 1948, to buy concentrates from the AEC owned mill at Durango, which VCA had leased with an option to buy.

Since a market had developed VCA began reopening their inactive mines which had previously been mined for vanadium. Using

Navajo miners, VCA resumed production on the West Reservation Lease, and on the Rattlesnake No. 1 Lease in October and November. 1948 respectively. Initial production from the West Reservation Lease came from Plot 6 (Page Edwards, 1955, pers. comm.).

Anticipating a contract to mine on the government controlled UMDC plots, VCA began mining on Cove Mesa Plot 7 in December 1948. On February 17, 1949, effective October 8, 1948, VCA entered into contract AT(49-1 -305 with the AEC to mine the plots. Lease I-149-IND-6197 covering UMDC Plots 1 to 7, and A to E was transferred from UMDC to the AEC effective February 28, 1949.

Production in 1948 amounted to 584 tons of ore containing 2,473 pounds U_3O_8 (Fig. 2). Over 98 percent of the production came from the reworking of the mines on Plot 6 It is interesting to note that beginning in 1948 the mines on VCA's Plot 6 and those on Cove Mesa Plot 7 produced ore every consecutive year through 1956 and 1965, respectively.

The reopening of the Durango mill in March 1949 resulted in a shorter haulage for the mines in the Carrizo Mountains. Production increased in 1949 with mining expanding on Cove Mesa and in the Saytah Wash area where VCA began mining uraniferous material on Plots 1, 2, 4, and 6 through 12 which had been bypassed during the vanadium mining era. It was not until 1952 that VCA differentiated the numbers of the individual plots on ore receipts to the AEC. Hence, the exact source of the 5,417 tons containing 21,691 pounds U_3O_8 listed as West Reservation Lease (Table 1) can not be determined. VCA also mined at Rattlesnake No. 1 and on Plot E on Kinusta Mesa. During 1949 a total of 7,907 tons of ore

containing 25,161 pounds U_3O_8 were produced from the northern and western Carrizo Mountains. This represented the fifth highest production year in the history of the area (Fig. 2).

After reaching an early peak in 1949, production declined to a low of 673 tons of ore containing 2,441 pounds U_3O_8 in 1952 (Fig. 2). During this period VCA, using Navajo contractors, began mining on AEC plots in Saytah Canyon and Saytah Wash, and continued on Kinusta Mesa. VCA contractors also began mining on Plots 14, 15, and 16 on Eurida Mesa. At the same time, Thomas Clani began mining at his Black Rock Point property at Saytah Wash and his property on Kinusta Mesa. Other non-VCA operations, run by local Navajos, commenced at Cove Mesa, East Mesa, Kinusta Mesa, Saytah Wash, and at Whirling Mountain. The production decline in the early 1950s was due largely to the fact that all of the exposed ore in outcrops and in the old mines was depleted, and no exploration had occurred.

In the early 1950s, the Navajo Tribal Council adopted a series of resolutions dealing with uranium mining which were approved by the Commissioner of Indian Affairs. These resolutions developed the regulations for projecting and mining permits, mining leases, and royalty schedules. All prospectors needed to obtain permits for prospecting. Mining permits were granted to only Navajos who could assign them to non-Navajos. Mining leases were no longer the subject of competitive bidding, but were negotiated with the Tribal Council, subject to approval of the Bureau of Indian Affairs. These actions would greatly increase prospecting and mining in the Carrizo Mountains and throughout

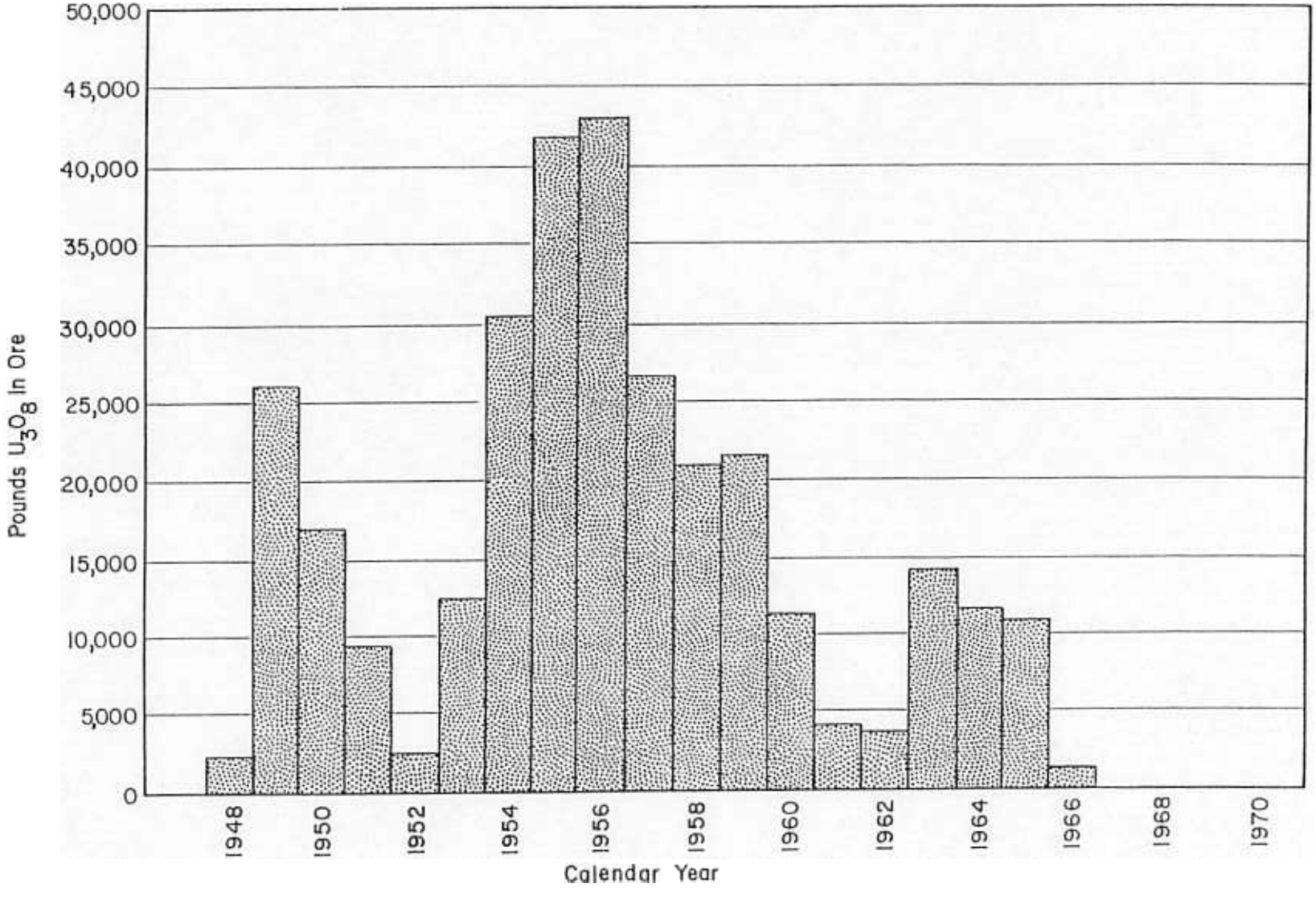

Figure 2. Uranium production northern and western Carrizo Mou ta ns, Apache County A zona

Navajo Reservation.

On January 7, 1952, the AEC opened an ore-buying station at Shiprock, New Mexico. This station provided a nearby market for independent producers in the Four Corners area. On June 30, 1953, VCA exercised their option and purchased the Durango mill the AEC.

Exploration drilling by both the AEC and uranium companies commenced in 1953, with the result that additional orebodies were discovered in the Saytah Wash and Cove Mesa areas. The most significant discovery was made west of the old Martin Mine on Plot 1, and on the adjacent George Simpson property. Drifting from the Martin Mine to reach the Simpson ore also mined the new ore on Plot 1. Additional ore on the Simpson property was discovered behind the old Saytah workings. Production from the Martin and Saytah Mines during 1954-1956 bolstered production from this area.

The Zona Mine, located high in the Carrizos south of Teec Pos, began production in 1953 which would last through 1955. Sustained production on the Cato Sells property on the north end of Cove Mesa began in 1956

There were more mining operations in the northern and western Carrizo Mountains during the mid-1950s than at any other time. Besides the mines already mentioned, there were many small operations throughout the area. As a result, uranium production reached an all-time high in 1956 when 14 properties produced 10,130 tons of ore containing 42,667 pounds U_3O_8 (Fig. 2). Of the total uranium, 62 percent came from Plot 7 alone. On November 1,

the new Kerr-McGee Oil Industries, Inc. mill at Shiprock, New Mexico began operating and purchasing ore from independent producers. Operation of the ore buying station was taken over by Kerr-McGee. The ore purchased by the AEC at the buying station was subsequently sold to Kerr-McGee along with ore from AEC ore buying stations.

VCA cancelled their Rattlesnake No. 1 lease (I-149-IND-6342) on March 1, 1955. Three months later the ground was acquired by

Shorty as Mining Permit 309 and assigned to Sylvania Mining Company, who produced ore in 1955 and 1956.

Industry drilling located additional ore on the George Simpson property which was mined in 1957-58 via an inclined shaft. New ore was found on the western part of Plot 6 and on the adjacent Pope property which was produced in 1958-59.

On June 30, 1958, contract AT(49-1)-305 between the AEC and VCA expired, but on July 1, 1958, a new contract went into effect This contract, AT(05-1)-756, covered only Plot 7 on Cove Mesa The other plots, 1 to 6 and A to E, were dropped for lack of recent production. Effective midnight June 30, 1961, Lease I-149-IND-6197 was cancelled by the AEC and control of the plot reverted to the Navajo Tribe. The ground was immediately acquired by William George as Mining Permit 558 who assigned it to VCA so they, and their contractors, could continue producing. During the period the AEC lease was in effect 30,058 tons of ore were produced from

7.

After reaching a high in 1956, production gradually declined in 1962 to a low of 984 tons containing 3,660 pounds U_3O_8 as the

known orebodies were depleted (Fig.

In 1963, production increased to 3,953 tons of ore containing 14,101 pounds U_3O_8 as Kerr-McGee's Block K Mine in the sand covered plain north of Saytah Wash reached optimum production. On March 1, 1963, VCA acquired the Kerr-McGee mill at Shiprock and closed its Durango mill later that month. Also acquired were the Kerr-McGee properties on the reservation, which included the Block K Mine in the northwest Carrizos. In the Carrizos, material which was previously considered uneconomical by VCA, because of the long haulage to Durango, could now be mined

Additional ore also was developed on Cove Mesa Plot 7, Cato Sells' Cove Mesa property, in the western part of VCA's Plot 6, and on the adjacent Hoskie Henry property, which would contribute to the area's production in the next few years.

As this ore was depleted, production declined, and in 1966 the final shipments were made from the Black Rock Point, Hoskie Henry, and Plot 6. Production for 1966 totaled 381 tons of ore containing 1,384 pounds U_3O_8 (Fig. 2). The final shipment from the area was made in June 1966.

VCA was merged into Foote Mineral Company on August 31, 1967. Foote continued the Shiprock milling operation until May 1968 when the operations ceased

Sixty properties in the northern and western Carrizo Mountains have produced 73,118 tons of ore containing 307,024 pounds U_3O_8 averaging 0.21 percent U_3O_8 since 1948. In addition, these ores contained 2,391,733 pounds V_2O_5 averaging 1.64 percent V_2O_5

A distribution of the size of the properties is given below:

Pounds U_3O_8	No. of Properties
Less than 500	38
500 to 1,000	4
1,001 to 5,000	8
5,001 to 10,000	8
10,001 to 50,000	0
Greater than 50,000	2
Total	60

Properties originally acquired for vanadium in the 1940s by Wade, Curran and Co., VCA, and Curran Brothers and Wade would later produce 237,456 pounds U_3O_8, or 77 percent of the total uranium produced in the northern and western Carrizo Mountains. It is interesting to note that two areas contained about three-fourths of the total uranium produced in the area. Some 169,221 pounds U_3O_8 or 55 percent of the total came from mines on Cove Mesa, a small isolated mesa with an areal extent of 0.76 square miles. In the Saytah Wash area, Plot 6, Black Rock Point, Pope and Hoskie Henry Mines, an area of 0.19 square miles, produced at least 65,000 pounds U_3O_8, amounting to 21 percent of the total.

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INDEX OF MINES

NO.	MINE NAME
1.	Barton 3
2.	Tom Morgan 1
3.	John Lee Benally
4.	Phillip Dee 1
5.	Johnny McCoy 1
6.	Brodie 1
7.	John Kee 4
8.	Capitan Benally 4A
9.	Block K
10.	Silentman 1
11.	McKenzie 3
12.	Plot 1 (Hogan Mine)
13.	Plot 2
14.	Plot 4 (Gila Mine)
15.	Pope 1
16.	Hoskie Henry
17.	Plot 6 (Rattlesnake Mines)
18.	Black Rock Point Mines
19.	Plot 8
20.	Sandy K
21.	Jimmie Bileen 1
22.	Plot 9
23.	Plot 10 (Horse Mine)
24.	Plot 11 (Two Level Mine)
25.	Plot 7 (Rattlesnake No. 5 Mine)
26.	Tsosie 1
27.	Grover Cleveland 1
28.	Plot 12 (Rattlesnake No. 8 Mine)
29.	North Martin (AEC Plot 2)
30.	Martin (AEC Plot 1); Geo. Simpson 1
31.	George Simpson 1 Incline
32.	Last Chance
33.	Carson
34.	Plot 13
35.	Saytah
36.	Melvin Benally 1
37.	Saytah Canyon (AEC Plot 4)
38.	School Boy
39.	CBW-MC (AEC Plot 5)
40.	Eurida Mines (AEC Plot 6)
41.	Eurida Mesa (Plots 14, 15, 16)
42.	Sunnyside
43.	Mildred 1
44.	Chester Mud 1
45.	Sheepskin Mesa (Hanley)
46.	Tree Mesa (Clani)
47.	Kinusta Mesa (AEC Plot E)
48.	Tohe Thlany Begay
49.	Cove Mesa Mines (Sells)
50.	Cove Mesa Mines (AEC Plot 7)
51.	East Mesa Mines
52.	West Mesa
53.	Rattlesnake 1 (Shorty)
54.	Bettie 1
55.	Zona 1
56.	Ruben 1
57.	Jim Lee 1; Richard King 1
58.	Todakonzie 1
59.	Harvey Begay 3
60.	Tony Tuc
61.	Upper Red Canyon
62.	King 6
63.	Beclabito Lease (BB)
64.	Rocky Flats 1, 2 (Rocky 1, 2)
65.	Canyon 1
66.	John John 1
67.	King 2
68.	Cottonwood Butte (Plot 8)
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71.	Hazel
72.	White Cap (Plot 11)
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77.	Oak Springs (Gravel Cap)
78.	Oak Springs (Plot 10)
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81.	Franks Point (Plot 6)
82.	Upper and Lower Salt Rock
83.	Williams Point (Plot 4)
84.	Sunnyside and Lookout Point (Plot 3)
85.	Lookout Point Incline (Plot 3)
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89.	Tent
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91.	Begay Incline
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95.	King Tutt 1
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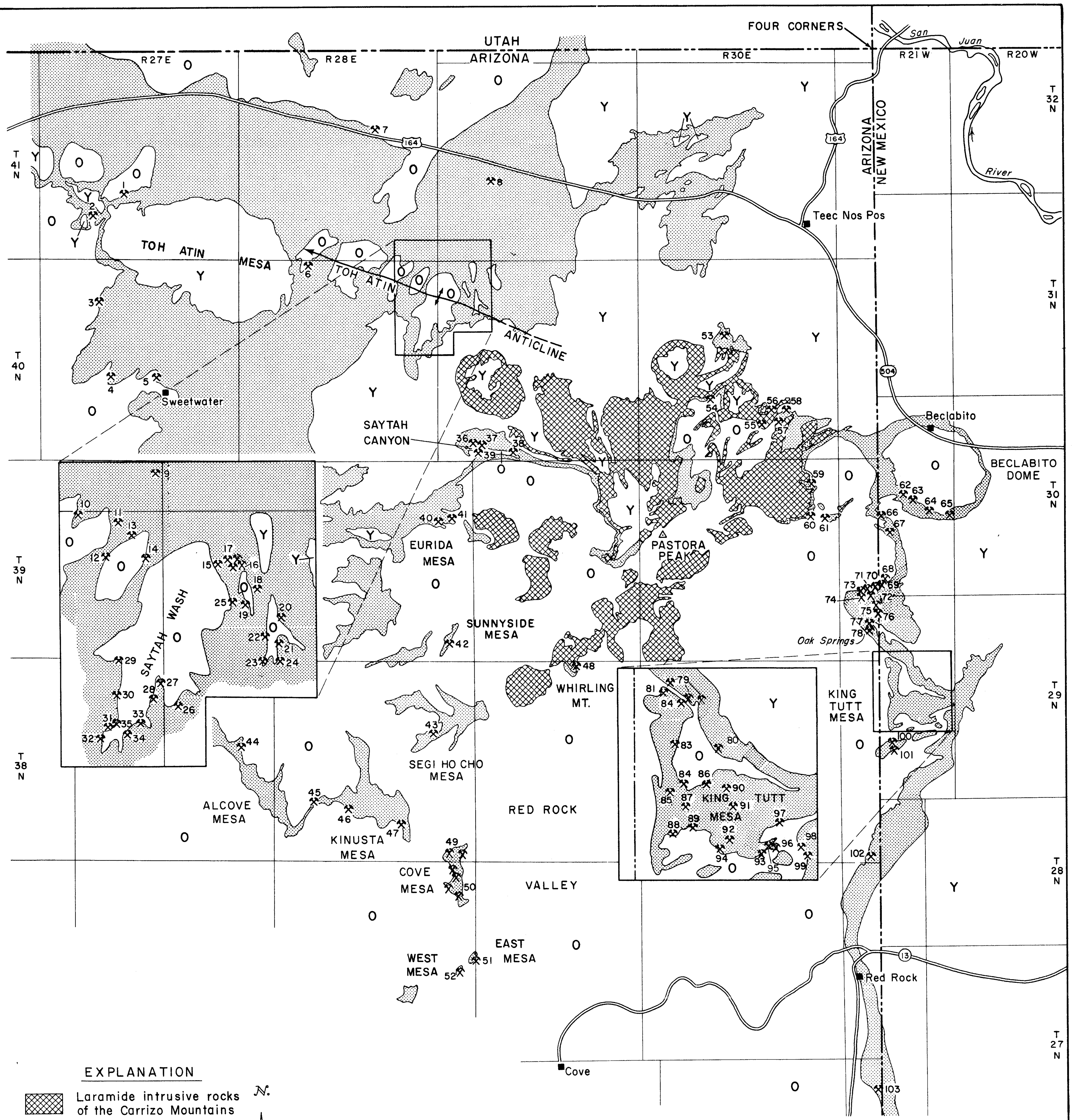
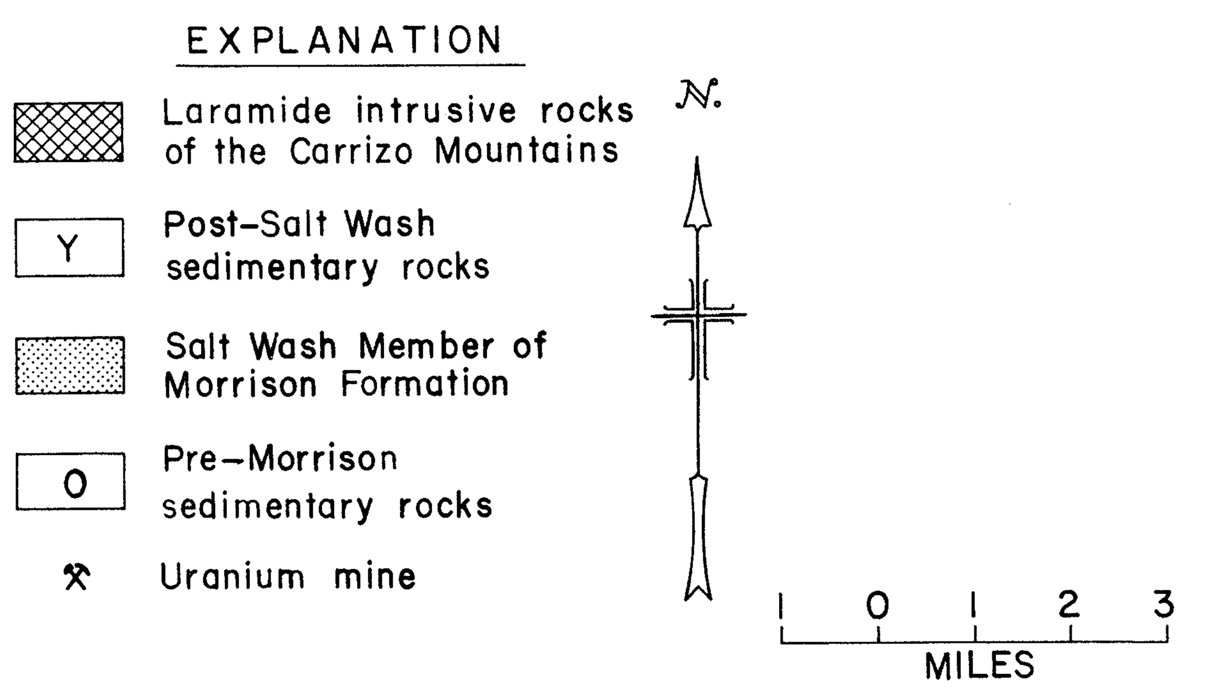
98.	Alongo
99.	Red Wash (Hosteen S. Begay)
100.	Red Rock
101.	Red Wash (Leroy Pettigrew)
102.	Upper Red Wash (Nakai Chee Begay)
103.	Rocky Spring





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Geology after Cooley and others, 1969

ARIZONA BUREAU OF GEOLOGY
AND MINERAL TECHNOLOGY
Open-File Report 85-13

JR KOSTA Expl. ml
Job# Disk "G" 03/27/84

Figure I. Mine Location Map, Carrizo Mountains Uranium Area, Apache County, Arizona and San Juan County, New Mexico.